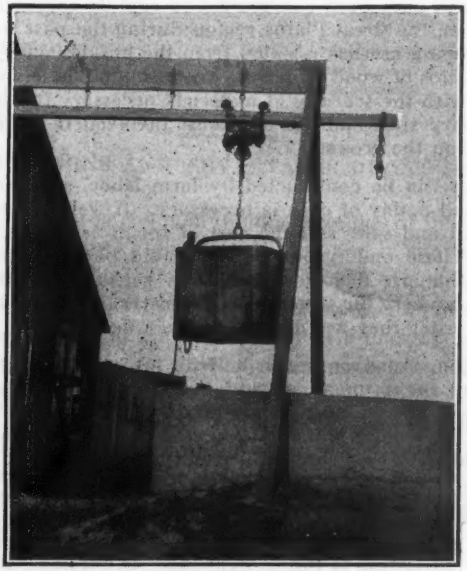
PIT SILOS

T. PRYSE METCALFE and GEORGE A. SCOTT

Animal Husbandry Division



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FARMERS' BULLETIN 825

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Animal Industry

A. D. MELVIN, Chief

Washington, D. C. June, 1917

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PIT SILOS have been constructed in rapidly increasing numbers in the Great Plains region during the past few years. Their growing use has resulted from the unsatisfactory service given by silos of wood under the prevailing climatic conditions, together with the scarcity of materials necessary for constructing masonry silos and the high cost involved in getting these materials on the ground.

Pit silos can be constructed by farm labor, and a comparatively small outlay of cash is necessary. If well made they are permanent and safe, and the cost of repair is practically negligible. These underground silos should be constructed only in soils that are firm and free from rocks, sand strata, and seeps, and where the water table is always below the bottom of the floor after they are dug.

Directions are given in this bulletin for constructing pit silos, indicating the proper size and best location. The practices which have proved most satisfactory are described so that a pit silo may be made without unnecessary mistakes which would cause undue waste of time and material.

While the feeding of silage can usually be done more easily and more rapidly from the above-ground types of silos, the use of types of hoists described and illustrated herein has shown that this advantage is but a slight one.

The construction of pit silos is recommended only where a combination of soil and climatic conditions exists such as is found in the Great Plains region.

In the absence of these special conditions the ordinary types of silos, described in Farmers' Bulletin 589, "Homemade Silos," are recommended.

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ADAPTATIONS AND ADVANTAGES OF PIT SILOS.

Pit silos are becoming common in many sections of the Great Plains region, especially in the Panhandle of Texas and in similar sections of the United States. The popularity of this type of silo is due chiefly to the remoteness of many farms in these sections from railroad points, which in many cases would make the cost of a masonry silo prohibitive, and to the fact that silos of wood often weaken rapidly under the peculiar climatic conditions prevailing in the Plains region and are destroyed by wind. The cost of constructing a pit silo is small compared with the expense of building a masonry silo, when large quantities of cement, sand, gravel, or tile, etc., must be bought and hauled long distances. In addition to this, some skilled labor usually must be employed in the building of a concrete or tile silo, whereas with a small outlay of cash, his own labor and that of ordinary farm hands, usually none too busy during the late summer months, the farmer can construct a pit silo that will be a substantial asset to his farm.

Simply digging a "hole in the ground" does not provide a durable or satisfactorily pit silo. A little extra care and expense put into the construction will well repay the owner in greater safety, efficiency, and durability. Properly constructed pit silos should last indefinitely, and the upkeep is very small. They can not be blown down, and there is nothing about the silo itself to decay. They preserve silage fully as well as or better than above-ground types; a more uniform temperature throughout the year is maintained in them; and the silage is never frozen.

Another distinct advantage of pit silos over other silos lies in the ease and low cost of filling them. Only power to cut the material is

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required, while with above-ground silos practically twice as much power must be used to cut the silage and elevate it to the top of the silo. Consequently, farmers having pit silos can more often afford to own their own cutting outfits, and can fill their silos at the proper time without waiting to hire expensive outfits and extra men. The labor required to hoist out the silage is distributed throughout the feeding season, which comes during a period when other farm work is not pressing.

LOCATION; CHARACTER OF SOIL REQUIRED.

Inasmuch as it is impracticable and even dangerous to dig a pit silo in a great many soils, the farmer should know the character of his soil before attempting to construct a silo of this type. The soil must be well drained, so that water will not stand in the bottom of the silo, and of such a nature that it will not readily cave in. Soils which contain bowlders or rocks are hardly satisfactory for pit silos, as the walls of the silo can hardly escape being materially defaced and weakened when the rocks are removed. Any firm, well-drained, and comparatively dry soil, free from seeps, rocks, and sand strata should prove satisfactory. Where pit silos have not been tried, the farmer should study the soil and the depth of the water table by observing any nearby well. If this is not possible, it would be advisable to bore a 2-inch hole as deep as the silo is to be, and in this way to learn the character of the soil. The maximum height of any ground water which may appear at any time in this test well will indicate the lowest point to which a pit silo should be dug in that place.

If possible the silo should be located near the feed lot to reduce the cost of feeding. If the feeding is to be done in a barn, a distance of 5 or 6 feet at least should be left between the edge of the pit and the barn.

SIZE OF SILO.

The diameter of the silo will be determined by the amount of silage to be fed daily, while the depth will depend chiefly upon the length of the feeding season. Hence the farmer should know approximately (1) the number of stock he intends to feed, (2) the approximate amount of silage to be fed daily, and (3) the number of days silage is to be fed. With this information before him, the proper diameter and depth, respectively, can be decided upon by consulting Tables I and II, which are here incorporated from Farmers' Bulletin 589.

TABLE I.—*Relation of size of herd to diameter of silo for winter feeding (on basis of 40 pounds of silage per cubic foot).*

Inside diameter of silo.	Quantity of silage in depth of 2 inches.	Number of animals that may be fed, allowing—			
		40 pounds per head.	30 pounds per head.	20 pounds per head.	15 pounds per head.
Feet.	*Pounds.*				
10	524	13	17	26	35
11	634	16	21	31	42
12	754	19	25	37	50
13	885	22	29	44	59
14	1,026	25	34	51	68
15	1,178	29	39	59	78
16	1,340	33	44	67	89
17	1,513	38	50	75	101
18	1,696	42	56	85	113
20	2,094	52	70	104	139

TABLE II.—*Depth of silage (after settling) for a given capacity of silo with a given diameter.*[1]

Depth of silage (after settling).	Capacity of silo having an inside diameter of—									
	10 feet.	11 feet.	12 feet.	13 feet.	14 feet.	15 feet.	16 feet.	17 feet.	18 feet.	20 feet.
Feet.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
24	34	.....	.....	.....	.....	.....	.....	.....	.....	.....
26	38	46	55	.....	.....	.....	.....	.....	.....	.....
28	42	51	61	71	83	.....	.....	.....	.....	.....
30	47	56	67	79	91	105	.....	.....	.....	.....
32	.....	62	74	86	100	115	131	.....	.....	.....
34	.....	.....	80	94	109	126	143	161	.....	.....
36	.....	.....	87	102	119	136	155	175	196	.....
38	.....	.....	.....	110	128	147	167	189	212	261
40	.....	.....	.....	.....	138	158	180	203	228	281
42	.....	.....	.....	.....	.....	170	193	218	245	302
44	.....	.....	.....	.....	.....	.....	207	234	262	323
46	.....	.....	.....	.....	.....	.....	.....	250	280	345
48	.....	.....	.....	.....	.....	.....	.....	.....	.....	368

[1] These figures were taken in part from King's Physics of Agriculture, p. 424.

The diameter of the silo should be such that after the silage feeding has begun, at least 2 inches should be removed from the surface daily. If less than 2 inches of silage is removed daily, the exposed silage will probably spoil, especially during warm weather. Make an allowance of 4 to 6 feet for settling of the silage, but figure in the wall above ground in the total depth of the silo. A general rule which is followed in silo construction is that the depth of the silo should not be less than twice nor more than three times the diameter. However, pit silos are seldom deeper than 36 feet.

METHOD OF CONSTRUCTION.

THE CURB.

When the location and size of the silo have been decided upon, mark off the trench for the curb with some such device as is shown in figure 1, keeping the arm of the marker level.

Dig a trench about 2 feet deep within these two outlined circles. This trench should be 6 to 8 inches across at the top. The inside wall should be kept perpendicular and smooth, and the bottom must be level. The concrete put into this trench forms the curbing at the top of the silo. This curb of concrete will serve as a foundation upon which a light wall and a cover may be built.

When the trench is dug, fill it with water to wet the ground thoroughly, and let it soak into the soil. Then put in the concrete, which is made of 1 part cement, 2 parts sand, 4 parts gravel or crushed rock, and the proper amount of water. To insure strength and durability the concrete must be reinforced. An ideal construction would result from embedding in the concrete three or four ¼-inch or ⅜-inch steel rods connected so as to form hoops, one of which should be near the bottom and the others placed approximately at equal distances apart as the concrete is put into the trench. Strong wire mesh securely connected at the ends may be used instead of steel rods.

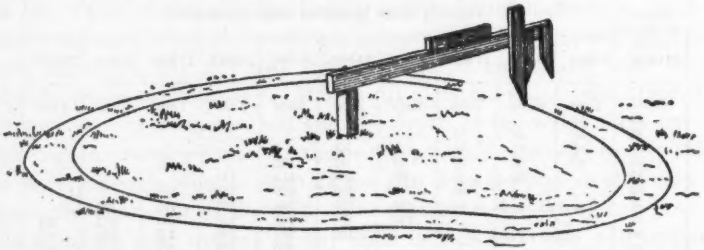

FIG. 1.—Marking off the trench for the curb. Where the ground on which the silo is to be located is not level, the markers can be lengthened by holding a longer board against either marker, as indicated in the figure, moving it up or down to keep it touching the ground, but care must be taken that the scantling is held level.

If a concrete wall is not to be constructed upon the curb, the latter should be extended about 2 feet above the ground, so that the soil can be banked up around it. Forms must be used for building the curb, or a wall, above ground. Farmers' Bulletin 461, The Use of Concrete on the Farm, and 589, Homemade Silos, give valuable information and detailed instructions concerning the mixing and handling of concrete, reinforcing concrete, the construction of forms for walls, etc. They may be had free upon request from the U. S. Department of Agriculture, Washington, D. C., and should be consulted in connection with the concrete work involved in building a pit silo, especially by those who are not thoroughly familiar with making and handling concrete.

EXCAVATING THE SOIL.

After the concrete composing the curb has set well—or in about 3 days—the digging of the pit may be started. Remove the soil, dig-

ging straight down from the inside of the curb. Be sure to keep the wall perpendicular and smooth. If the wall slopes outward, the silage will settle away, leaving an air space, and some silage will be spoiled. Should the wall slope inward, it will prevent proper settling of the silage.

Several devices have been used in helping to keep the wall straight and smooth. A simple plumb line is most often used, and a straight-

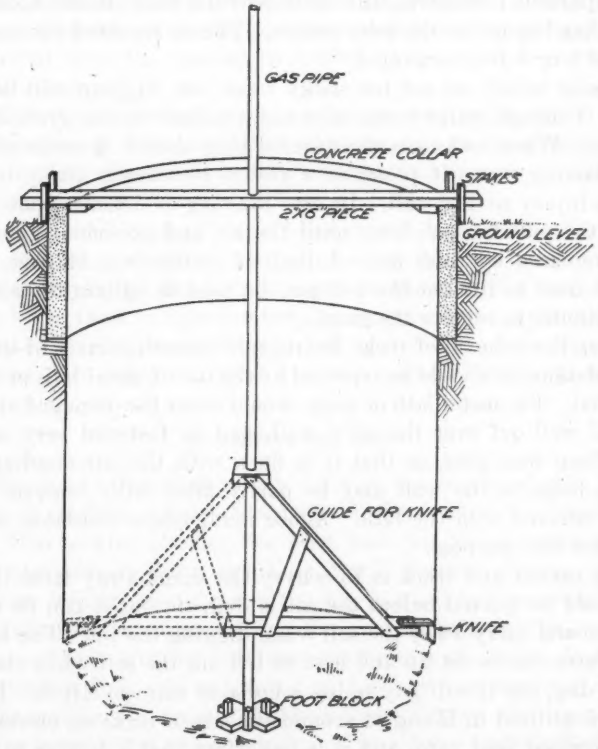

FIG. 2.—Vertical section of a partially constructed pit silo, showing a device for making the wall perpendicular and smooth. (Adapted from Circular No. 6 of the Extension Service of the University of Arizona College of Agriculture.

edge made from a 1 by 4 inch piece, used in connection with an ordinary carpenter's level, assists in keeping the wall both plumb and smooth. Figure 2 illustrates a device which has been used in the Southwest.

The stakes next to the curb and the blocks nailed on the lower surface of the 2 by 6 inch piece are put in place before the digging of the pit is started. The hole in the 2 by 6 inch piece through which the pipe passes is bored directly over the center of the silo. After

each section of the pit is dug, the 2 by 6 inch piece is put in place, and a plumb line is dropped through the hole to locate the exact center in the bottom. Then the foot block is staked in place and the pipe lowered through the 2 by 6 piece, the guide, and into the hole in the foot block. The guide is then revolved, and the knife shaves the wall smooth, or indicates irregularities in the wall. When the wall has been smoothed to the approximate level of the foot block, the apparatus is removed, this section of the wall plastered, and digging then begun for the next section. This is repeated for each section of 5 or 6 feet excavated.

In soils which are not too sticky when wet, digging will be made easier if enough water is run in at night to soak up the ground in the bottom. When rocks are encountered they should be removed without blasting them, if possible. Careless blasting is likely to cause undue injury to the wall. In case blasting is done, no one should enter the pit after the blast until the air and poisonous gases have been replaced by fresh air. A limb of a tree, or a blanket, or the bucket used to lift out the soil may be used to agitate the air for a few minutes to remove the gases.

When the removal of rocks destroys the smooth surface of the wall, the defacements should be repaired by the use of metal lath or similar material. The metal lath or mesh should cover the damaged area and extend well out over the solid wall, and be fastened very securely with long iron pins, so that it is flush with the surrounding wall. Large holes in the wall may be partly filled with concrete before being covered with the lath. Adobe mud, where available, is often used for this purpose.

If a carrier and track is to convey the silage away from the silo, it should be erected before the pit is dug, so that it can be used to remove and carry away the soil when digging the pit. The hoisting apparatus can be set up and used to lift out the soil while the pit is being dug, but it will pay to use a horse or team to lift it. The soil may be utilized in filling in around the silo to make an elevated and well-drained feed yard, and it is important that a foot or so of dirt be banked up against the curbing to prevent water draining into the silo.

LINING THE PIT.

When 5 or 6 feet have been excavated, the wall should be plastered about 1 inch thick with a mortar made of 1 part cement and 2 or 2½ parts of clean, sharp sand. Two coats will be required to do this, and at least two hours should elapse between the application of the first and second coats; but the second coat should be applied before the first has become completely dry. A lining 1 inch thick is

usually sufficient, but in soils which are not firm a 1½-inch wall would be safer.

Before applying the lining the wall should be dampened, in order to prevent the dry soil from absorbing the moisture too rapidly from the mortar. Before the plaster is set, apply one or two coats of a wash of pure cement and water, mixed to a creamy consistency. This may be done with a whitewash brush. The application of this last coat assists in making the wall stronger, smoother, air-tight, and almost waterproof. Keep the plastered wall damp for several days, as this will help the plaster to harden properly and a stronger wall will result.

It will be found desirable to leave bare an inch or so of the earth wall immediately below the curb until the silo is completely dug. This will allow the curb to settle without "buckling" or cracking of the lining below.

After the first section of 5 or 6 feet has been lined with the mortar and cement wash, digging may be resumed, and the work carried on in this way until the desired depth is reached. By completing the silo by sections in this manner the danger of caving in and the necessity of building scaffolding for the application of the lining are eliminated. Do not put mortar over the bottom. It should be left bare.

COMPLETING THE SILO.

A wall about 4 feet high is now built on the concrete curb. This may be of concrete, lumber, concrete blocks, hollow tile blocks, or brick. Woven-wire fencing has been used for this purpose; it is much better than nothing at all, as it will prevent persons or live stock from falling in, and when the silo is filled this wire wall can be filled also, so that upon settling the pit will be nearly full.

Forms are necessary for building a concrete wall, which should be about 4 inches thick and reinforced with heavy woven-wire fencing. It will be necessary to erect scaffolding across the top of the pit from which the inner forms can be suspended in place. Consult Farmers' Bulletin 589 for directions for building forms and making concrete walls. A wall approximately 4 feet high is desirable, as it adds that much depth to the silo and affords protection against falling in.

An inexpensive covering of some sort should be placed over the silo. A simple board roof is sufficient. It is best to leave a space of about 2 feet or more at the top of the wall to allow a free circulation of air around the top of the silo, which makes less probable the accumulation of poisonous gases.

Where a man furnishes all of his own labor, obtains sand and gravel at a small cost, and installs a homemade hoisting apparatus,

a 150 to 180 ton silo may be constructed for a cash outlay of about $75, as the cement is the chief item of cash expenditure.

HOISTING DEVICES AND FEEDING EQUIPMENT.

The problem of hoisting and feeding silage from pit silos is not as formidable as it appears to many on first thought. This is evident to one observing the ease and rapidity with which feeding is done by farmers who have pit silos. Practically all of the devices now in use are homemade affairs, which are inexpensive. A few of the most successful of these are illustrated and briefly described herewith.

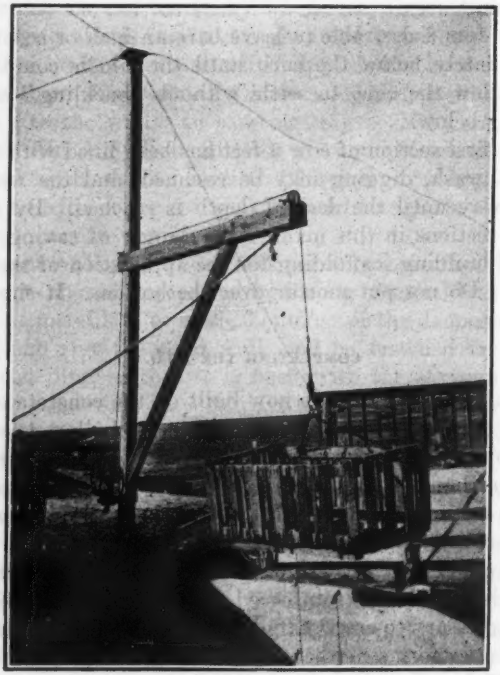

FIG. 3.—A simple type of hand hoist used in connection with a pit silo.

Figure 3 illustrates one of the most simple types in use. This device consists of a swinging crane, a windlass, pulleys and rope, and a box of some sort for the silage. A strong 4 by 6 inch piece may be used for the upright or mast, 2 by 6 or 2 by 8 inch pieces for the arm, and a 4 by 4 inch piece for the boom. Only sound timbers should be used. The windlass and the plates of iron on which the crane turns can be purchased at small cost. The upright should be braced from the top with heavy guy wires securely anchored. If desired, the windlass may be replaced by a pulley, and a horse or

a team used to lift the silage. This is the common practice where large numbers of cattle are fed. The silage box after being filled and hoisted can be swung over a wagon or attached to a trolley on an overhead track, or placed upon a truck, as is shown in figures 5 and 6. Such a hoisting device may be placed so that it can be used to empty two or even three silos. Whatever kind of carrier for the silage is built or purchased, it should have a trip bottom, end, or side, so that it may be unloaded easily.

The illustration on the front page of this bulletin shows one way in which a regular hay carrier and outfit is used to feed silage from a pit silo. The track extends into the barn above or in front of the

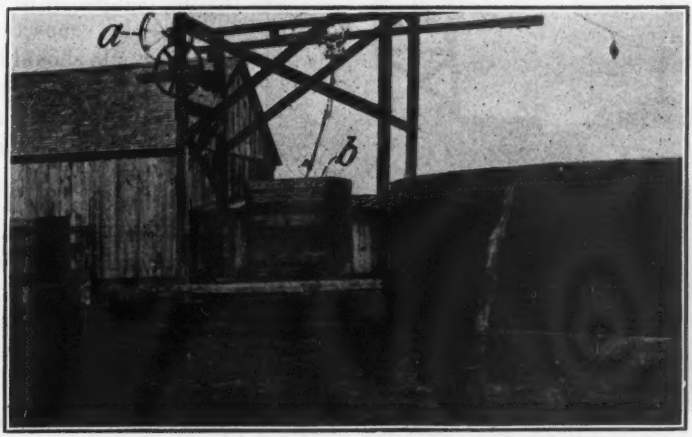

FIG. 4.—A well-inclosed pit silo, showing a combination hand hoist and hay carrier used to lift the silage. An endless rope or chain runs on the wheel "A" by which the windlass is operated. The silage box "B" is transferred to the truck and carried out along the continuous feed trough.

feed troughs. With the equipment shown here a horse is used to hoist the silage. However, it is possible to install a windlass for lifting the silage, and to use with this a simple trolley to which the silage carrier can be transferred after being filled and raised.

A type of hand hoist used in connection with a continuous feed trough is illustrated in figures 4 and 5. Over the wheel shown at "A" in figure 4 runs an endless rope or chain by which the windlass is operated. The drum or barrel on which the rope is wound when lifting the silage is shown at "A" in figure 5. In place of an overhead track and carrier, a truck is used to convey the silage out along the feed trough. The truck runs on the top edges of the 2-inch pieces that form the sides of the continuous trough arrangement shown in the figures. An overhead track and trolley could be used.

Figure 6 shows a large pit silo with a patented hoisting device, several of which are in use in the Texas Panhandle. With this hoist the feeder can lift himself and the silage out by the endless rope or chain which runs over the large wheel shown in the illustration. The silage carrier is transferred to the hooks on the trolley and run out over the feed trough.

With the framework over the silo constructed somewhat similar to that shown in figure 6, a horsepower hoist or a hand windlass could be installed. In case feeding could not be done near the silo, only a short track would be required to carry the silage to a wagon.

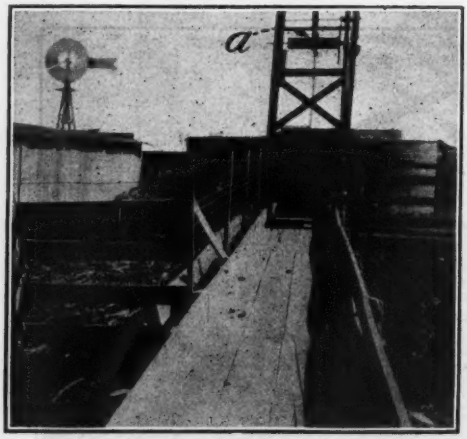

FIG. 5.—Another view of the silo and hoisting apparatus shown in figure 4. This illustrates the continuous feed trough, the top edges being used as a track for the truck. The barrel of the windlass on which the hoisting rope is wound is shown at "A."

The kind of hoist and feeding equipment to be installed in connection with a pit silo should be determined largely by the amount of silage to be fed and the conditions which affect feeding. A farmer should install a hoist and equipment that conform to his particular needs and plans, keeping in mind the desirability of convenience, durability, and safety.

POISONOUS GASES IN PIT SILOS.

Occasionally poisonous gases are formed in pit silos, and because the only means of ventilation is at the top, they may accumulate to such an extent that it is dangerous to enter. This formation and accumulation of dangerous gases practically always takes place only when the silo is partially filled with fresh silage. So particular care should be taken before entering a silo under those conditions. If a lighted lantern is lowered into the silo and continues to burn, it is safe to enter. When danger is suspected, thoroughly agitate the air, as mentioned in connection with blasting. Some farmers keep a rabbit in their pit silo, and as long as the rabbit is alive it is safe to enter. While very little trouble has been experienced from this source, it is well always to be certain that poisonous gases are not present before entering the pit silo.

POINTS TO BE EMPHASIZED.

Locate the silo so that feeding the silage can be done conveniently.

The silo must be in firm, well-drained soil, which should be free from sand strata and rocks.

Make the pit the proper size and depth, according to the amount of silage to be fed.

Make the bottom of the trench for the curbing or collar level, keep the inside of the trench smooth, and put in a substantial collar.

Keep the wall of the pit smooth and plumb.

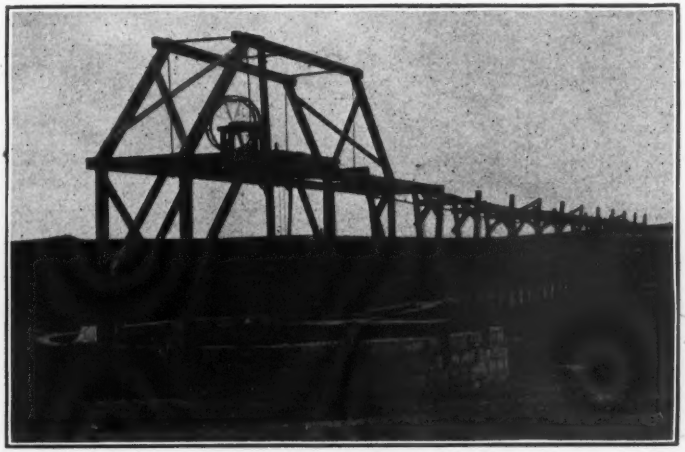

FIG. 6.—A large pit silo with the hoisting and feeding equipment used in connection. The hand hoist is patented. The silage is carried along on the track over the feed troughs. Framework over the troughs is made for a shed. Feeding can be done easily and rapidly with this equipment.

Make the mortar for the lining in the proportions indicated, first mixing well the sand and cement dry. Plaster this on to the dampened wall, as directed, and do not attempt to economize by making it less than 1 inch thick. Then keep the wall damp for several days.

Leave the bottom of the pit bare.

Remember that an efficient hoist greatly reduces the time and labor required to remove the silage.

Do not fail to inclose the pit with a wall of some sort, so that there will be no danger of anything falling into the silo.

Pit silos are usually constructed with the idea of permanency, so it is in the interest of economy and safety to construct them well.

PUBLICATIONS.

In connection with pit-silo construction the following bulletins are of value to farmers. They may be had upon request from the U. S. Department of Agriculture, Washington, D. C.

Farmers' Bulletin 461. Uses of Concrete on the Farm.

Farmers' Bulletin 481. Concrete Construction on the Live-Stock Farm.

Farmers' Bulletin 578. Making and Feeding Silage.

Farmers' Bulletin 589. Homemade Silos.

Farmers' Bulletin 724. Feeding Grain Sorghums to Live Stock.

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Pit silos can be constructed by farm labor at a comparatively small outlay of cash. If well made they are permanent and safe, and the cost of repair is practically negligible. These underground silos should be constructed only in soils that are firm and free from rocks, sand strata, and seeps, and where the water table is always below the bottom of the floor after they are dug.

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Washington, D. C. Issued June, 1917; slightly revised, January, 1923

PIT SILOS.

T. PRYSE METCALFE and GEORGE A. SCOTT,[1]
Animal Husbandry Division, Bureau of Animal Industry.

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Simply digging a "hole in the ground" does not provide a durable or satisfactory pit silo. A little extra care and expense put into the construction will well repay the owner in greater safety, efficiency, and durability. Properly constructed pit silos should last indefinitely, and the upkeep is very small. They can not be blown down, and there is nothing about the silo itself to decay. They preserve silage fully as well as or better than above-ground types; a more uniform temperature throughout the year is maintained in them; and the silage is never frozen.

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[1] Revised by W. H. Black, Animal Husbandman, Animal Husbandry Division. Mr. Metcalfe resigned Dec. 4, 1919, and Mr. Scott resigned Jan. 31, 1915.

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required, while with above-ground silos practically twice as much power must be used to cut the silage and elevate it to the top of the silo. Consequently, farmers having pit silos can more often afford to own their cutting outfits, and can fill their silos at the proper time without waiting to hire expensive outfits and extra men. The labor required to hoist out the silage is distributed throughout the feeding season, which comes during a period when other farm work is not pressing.

LOCATION—CHARACTER OF SOIL REQUIRED.

Inasmuch as it is impracticable and even dangerous to dig a pit silo in a great many soils, the farmer should know the character of his soil before attempting to construct a silo of this type. The soil must be well drained, so that water will not stand in the bottom of the silo, and of such a nature that it will not readily cave in. Soils which contain bowlders or rocks are hardly satisfactory for pit silos, as the walls of the silo can hardly escape being materially defaced and weakened when the rocks are removed. Any firm, well-drained, and comparatively dry soil, free from seeps, rocks, and sand strata should be satisfactory. Where pit silos have not been tried, the farmer should study the soil and the depth of the water table by observing any near-by well. If this is not possible, it would be advisable to bore a 2-inch hole as deep as the silo is to be, and in this way to learn the character of the soil. The maximum height of any ground water which may appear at any time in this test well will indicate the lowest point to which a pit silo should be dug in that place.

If possible the silo should be near the feed lot, to reduce the cost of feeding. If the feeding is to be done in a barn, a distance of 6 feet at least should be left between the edge of the pit and the barn.

SIZE OF SILO.

The diameter of the silo will be determined by the amount of silage to be fed daily, while the depth will depend chiefly upon the length of the feeding season. Hence the farmer should know approximately (1) the number of stock he intends to feed, (2) the approximate amount of silage to be fed daily, and (3) the number of days silage is to be fed. With this information before him, the proper diameter and depth, respectively, can be decided upon by consulting Table 1.

TABLE 1.—*Capacity of round silos.*[1]

Inside diameter.	Height.	Capacity.	Amount that should be fed daily.
Feet.	*Feet.*	*Tons.*	*Pounds.*
10	25	31.8	525
10	30	40.6	525
10	35	50.7	525
12	30	58	755
12	35	73	755
12	40	88	755
12	45	104	755
12	50	120	755
14	30	80	1,030
14	35	99	1,030
14	40	120	1,030
14	45	141	1,030
14	50	164	1,030
16	30	104	1,340
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18	40	198	1,700
18	45	234	1,700
18	50	271	1,700

[1] Data taken from Bulletin 189, Agricultural Experiment Station, Iowa State College, and based on the weighing of silage for five years in from three to five silos at the University of Nebraska Farm. Reported in Circular 1 of the University of Nebraska Agricultural Experiment Station.

The diameter of the silo should be such that after the silage feeding has begun, at least 2 inches should be removed from the surface daily. If less than 2 inches of silage is removed daily, the exposed silage will probably spoil, especially during warm weather. Make an allowance of 4 to 6 feet for settling of the silage, but figure in the wall above ground in the total depth of the silo. A general rule which is followed in silo construction is that the depth of the silo should not be less than twice nor more than three times the diameter. However, pit silos are seldom deeper than 36 feet.

METHOD OF CONSTRUCTION.

THE CURB.

When the location and size of the silo have been decided upon, mark off the trench for the curb with some such device as is shown in Figure 1, keeping the arm of the marker level.

Dig a trench about 2 feet deep within these two outlined circles. This trench should be from 6 to 8 inches across at the top. The inside wall should be kept perpendicular and smooth, and the bottom must be level. The concrete put into this trench forms the curbing at the top of the silo. This curb of concrete will serve as a foundation upon which a light wall and a cover may be built.

When the trench is dug, fill it with water to wet the ground thoroughly, and let it soak into the soil. Then put in the concrete, which

is made of 1 part cement, 2 parts sand, 4 parts gravel or crushed rock, and the proper amount of water. To insure strength and durability the concrete must be reinforced. An ideal construction results from embedding in the concrete three or four ¼-inch or ⅜-inch steel rods connected so as to form hoops, one of which should be near the bottom and the others placed approximately at equal distances apart as the concrete is put into the trench. Strong wire mesh securely connected at the ends may be used instead of steel rods.

If a concrete wall is not to be constructed upon the curb, the latter should be extended about 2 feet above the ground, so that the soil can be banked up around it. Forms must be used for building the curb, or a wall, above ground. Farmers' Bulletins 1480, Small Concrete Construction on the Farm, and 855, Homemade Silos, give

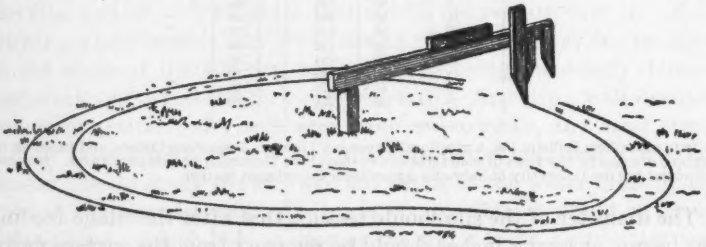

FIG. 1.—Marking off the trench for the curb. Where the ground on which the silo is to be located is not level, the markers can be lengthened by holding a longer board against either marker, as indicated in the figure, moving it up or down to keep it touching the ground, but care must be taken that the scantling is held level.

valuable information and detailed instructions concerning the mixing and handling of concrete, reinforcing concrete, the construction of forms for walls, etc. They may be obtained free from the U. S. Department of Agriculture, Washington, D. C., and should be consulted in connection with the concrete work involved in building a pit silo, especially by those who are not thoroughly familiar with making and handling concrete.

EXCAVATING THE SOIL.

After the concrete composing the curb has set well—or in about 3 days—the digging of the pit may be begun. Remove the soil, digging straight down from the inside of the curb. Be sure to keep the wall perpendicular and smooth. If the wall slopes outward, the silage will settle away, leaving an air space, and some silage will be spoiled. Should the wall slope inward, it will prevent proper settling of the silage.

Several devices have been used in helping to keep the wall straight and smooth. A simple plumb line is most often used, and a straightedge made from a 1 by 4 inch piece, used in connection with an

ordinary carpenter's level, assists in keeping the wall both plumb and smooth. Figure 2 illustrates a device which has been used in the Southwest.

The stakes next to the curb and the blocks nailed on the lower surface of the 2 by 6 inch piece are put in place before the digging of the pit is started. The hole in the 2 by 6 inch piece through which the pipe passes is bored directly over the center of the silo. After

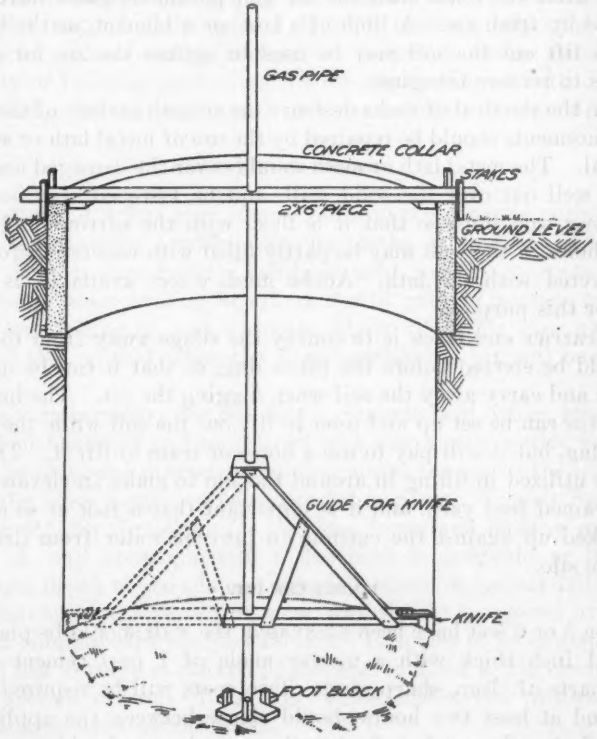

FIG. 2.—Vertical section of a partially constructed pit silo, showing a device for making the wall perpendicular and smooth. (Adapted from Circular No. 6 of the Extension Service of the University of Arizona College of Agriculture.)

each section of the pit is dug, the 2 by 6 inch piece is put in place, and a plumb line is dropped through the hole to locate the exact center in the bottom. Then the foot block is staked in place and the pipe lowered through the 2 by 6 piece, the guide, and into the hole in the foot block. The guide is then revolved, and the knife shaves the wall smooth, or indicates irregularities in the wall. When the wall has been smoothed to the approximate level of the foot block, the apparatus is removed, this section of the wall plastered, and dig-

ging then begun for the next section. This is repeated for each section of 5 or 6 feet excavated.

In soils which are not too sticky when wet, digging will be made easier if water enough is run in at night to soak up the ground in the bottom. When rocks are encountered they should be removed without blasting, if possible. Careless blasting is likely to cause undue injury to the wall. In case blasting is done, no one should enter the pit after the blast until the air and poisonous gases have been replaced by fresh air. A limb of a tree, or a blanket, or the bucket used to lift out the soil may be used to agitate the air for a few minutes to remove the gases.

When the removal of rocks destroys the smooth surface of the wall, the defacements should be repaired by the use of metal lath or similar material. The metal lath or mesh should cover the damaged area and extend well out over the solid wall, and be fastened very securely with long iron pins, so that it is flush with the surrounding wall. Large holes in the wall may be partly filled with concrete before being covered with the lath. Adobe mud, where available, is often used for this purpose.

If a carrier and track is to convey the silage away from the silo, it should be erected before the pit is dug, so that it can be used to remove and carry away the soil when digging the pit. The hoisting apparatus can be set up and used to lift out the soil while the pit is being dug, but it will pay to use a horse or team to lift it. The soil may be utilized in filling in around the silo to make an elevated and well-drained feed yard, and it is important that a foot or so of dirt be banked up against the curbing to prevent water from draining into the silo.

LINING THE PIT.

When 5 or 6 feet have been excavated, the wall should be plastered about 1 inch thick with a mortar made of 1 part cement and 2 or 2½ parts of clean, sharp sand. Two coats will be required to do this, and at least two hours should elapse between the application of the first and second coats; but the second coat should be applied before the first has become completely dry. A lining 1 inch thick is usually sufficient, but in soils which are not firm a 1½-inch wall would be safer.

Before applying the lining the wall should be dampened, in order to prevent the dry soil from absorbing the moisture too rapidly from the mortar. Before the plaster is set, apply one or two coats of a wash of pure cement and water, mixed to a creamy consistency. This may be done with a whitewash brush. The application of this last coat assists in making the wall stronger, smoother, air-tight, and almost waterproof. Keep the plastered wall damp for several days,

as this will help the plaster to harden properly and a stronger wall will result.

It will be found desirable to leave bare an inch or so of the earth wall immediately below the curb until the silo is completely dug. This will allow the curb to settle without "buckling" or cracking the lining below.

After the first section of 5 or 6 feet has been lined with the mortar and cement wash, digging may be resumed, and the work carried on in this way until the desired depth is reached. By completing the silo by sections in this manner the danger of caving in and the necessity of building scaffolding for the application of the lining are eliminated. Do not put mortar over the bottom. It should be left bare.

COMPLETING THE SILO.

A wall about 4 feet high is now built on the concrete curb. This may be of concrete, lumber, concrete blocks, hollow tile blocks, or brick. Woven-wire fencing has been used for this purpose; it is much better than nothing at all, as it will prevent persons or live-stock from falling in, and when the silo is filled this wire wall can be filled also, so that when the silage settles, the pit will be nearly full.

Forms are necessary for building a concrete wall, which should be about 4 inches thick and reinforced with heavy woven-wire fencing. It will be necessary to erect scaffolding across the top of the pit from which the inner forms can be suspended in place. Consult Farmers' Bulletin 855 for directions for building forms and making concrete walls. A wall approximately 4 feet high is desirable, as it adds that much depth to the silo and affords protection against falling in.

An inexpensive covering of some sort should be placed over the silo. A simple board roof is sufficient. It is best to leave a space of about 2 feet or more at the top of the wall to allow a free circulation of air around the top of the silo, which makes less probable the accumulation of poisonous gases.

Where a man furnishes all his own labor, obtains sand and gravel at a small cost, and installs a homemade hoisting apparatus, a silo of considerable capacity may be constructed for a comparatively small cash outlay, as the cement is the chief item of cash expenditure.

HOISTING DEVICES AND FEEDING EQUIPMENT.

The problem of hoisting and feeding silage from pit silos is not so formidable as it appears to many on first thought. This is evident to one observing the ease and rapidity with which feeding is done by farmers who have pit silos. Practically all the devices now in use

are homemade affairs, which are inexpensive. A few of the most successful of these are illustrated and briefly described herewith.

Figure 3 illustrates one of the most simple types in use. This device consists of a swinging crane, a windlass, pulleys and rope, and a box of some sort for the silage. A strong 4 by 6 inch piece may be used for the upright or mast, 2 by 6 or 2 by 8 inch pieces for the arm, and a 4 by 4 inch piece for the boom. Only sound timbers should be used. The windlass and the plates of iron on which the

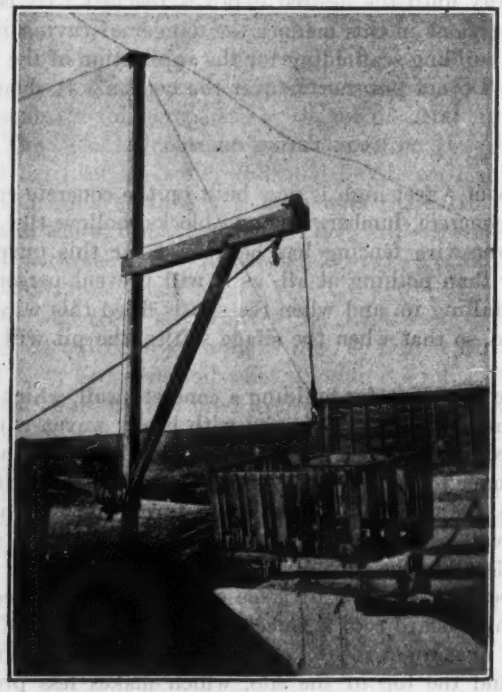

FIG. 3.—A simple type of hand hoist used in connection with a pit silo.

crane turns can be purchased at small cost. The upright should be braced from the top with heavy guy wires securely anchored. If desired, the windlass may be replaced by a pulley, and a horse or a team used to lift the silage. This is the common practice where large numbers of cattle are fed. The silage box after being filled and hoisted can be swung over a wagon or attached to a trolley on an overhead track, or placed upon a truck, as is shown in Figures 5 and 6. Such a hoisting device may be placed so that it can be used to empty two or even three silos. Whatever kind of carrier for the silage is built or purchased, it should have a trip bottom, end, or side, so that it may be unloaded easily.

The illustration on the title page of this bulletin shows one way in which a regular hay carrier and outfit is used to feed silage from a pit silo. The track extends into the barn above or in front of the feed troughs. With the equipment shown here a horse is used to hoist the silage. However, it is possible to install a windlass for lifting the silage, and to use with this a simple trolley to which the silage carrier can be transferred after being filled and raised.

A type of hand hoist used in connection with a continuous feed trough is illustrated in Figures 4 and 5. Over the wheel shown at "*a*" in Figure 4 runs an endless rope or chain by which the windlass

FIG. 4.—A well-inclosed pit silo, showing a combination hand hoist and hay carrier used to lift the silage. An endless rope or chain runs on the wheel "*a*" by which the windlass is operated. The silage box "*b*" is transferred to the truck and carried out along the continuous feed trough.

is operated. The drum or barrel on which the rope is wound when lifting the silage is shown at "*a*" in Figure 5. In place of an overhead track and carrier, a truck is used to convey the silage out along the feed trough. The truck runs on the top edges of the 2-inch pieces that form the sides of the continuous-trough arrangement shown in the figures. An overhead track and trolley could be used.

Figure 6 shows a large pit silo with a patented hoisting device, several of which are in use in the Texas Panhandle. With this hoist the feeder can lift himself and the silage out by the endless rope or chain which runs over the large wheel shown in the illustration. The silage carrier is transferred to the hooks on the trolley and run out over the feed trough.

With the framework over the silo constructed somewhat similar to that shown in Figure 6, a horsepower hoist or a hand windlass could

be installed. In case feeding could not be done near the silo, only a short track would be required to carry the silage to a wagon.

The kind of hoist and feeding equipment to be installed in connection with a pit silo should be determined largely by the amount of silage to be fed and the conditions which affect feeding. A farmer should install a hoist and equipment that conform to his particular needs and plans, keeping in mind the desirability of convenience, durability, and safety.

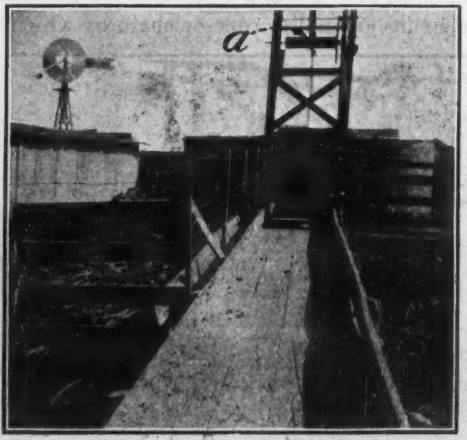

FIG. 5.—Another view of the silo and hoisting apparatus shown in Figure 4. This illustrates the continuous feed trough, the top edges being used as a track for the truck. The barrel of the windlass on which the hoisting rope is wound is shown at "*a*."

POISONOUS GASES IN PIT SILOS.

Occasionally poisonous gases are formed in pit silos, and because the only means of ventilation is at the top, they may accumulate to such an extent that it is dangerous to enter. This formation and accumulation of dangerous gases practically always takes place only when the silo is partially filled with fresh silage. So particular care should be taken before entering a silo under those conditions. If a lighted lantern is lowered into the silo and continues to burn, it is safe to enter. When danger is suspected, thoroughly agitate the air, as mentioned in connection with blasting. While very little trouble has been experienced from this source, it is well always to be certain that poisonous gases are not present before entering the silo.

POINTS TO BE EMPHASIZED.

Locate the silo so that feeding the silage can be done conveniently.

The silo must be in firm, well-drained soil, which should be free from sand strata and rocks.

Make the pit the proper size and depth, according to the amount of silage to be fed.

Make the bottom of the trench for the curbing or collar level, keep the inside of the trench smooth, and put in a substantial collar.

Keep the wall of the pit smooth and plumb.

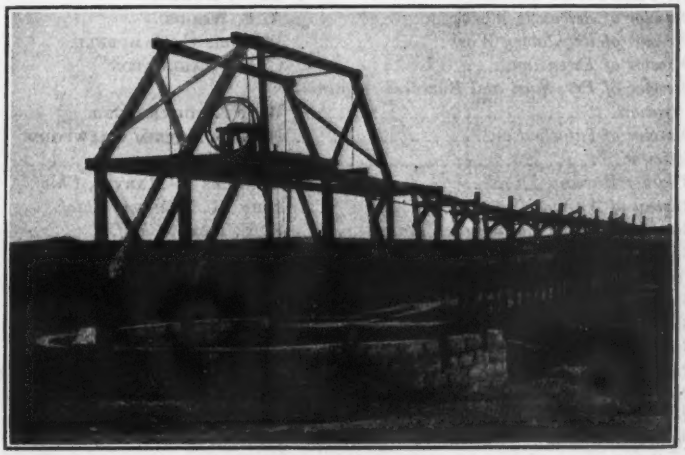

FIG. 6.—A large pit silo with the hoisting and feeding equipment used in connection. The hand hoist is patented. The silage is carried along on the track over the feed troughs. Feeding can be done easily and rapidly with this equipment.

Make the mortar for the lining in the proportions indicated, first mixing well the sand and cement dry. Plaster this on to the dampened wall, as directed, and do not attempt to economize by making it less than 1 inch thick. Then keep the wall damp for several days.

Leave the bottom of the pit bare.

Remember that an efficient hoist greatly reduces the time and labor required to remove the silage.

Do not fail to inclose the pit with a wall of some sort, so that there will be no danger of anything falling into the silo.

Pit silos are usually constructed with the idea of permanency, so it is in the interest of economy and safety to construct them well.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

November 21, 1928

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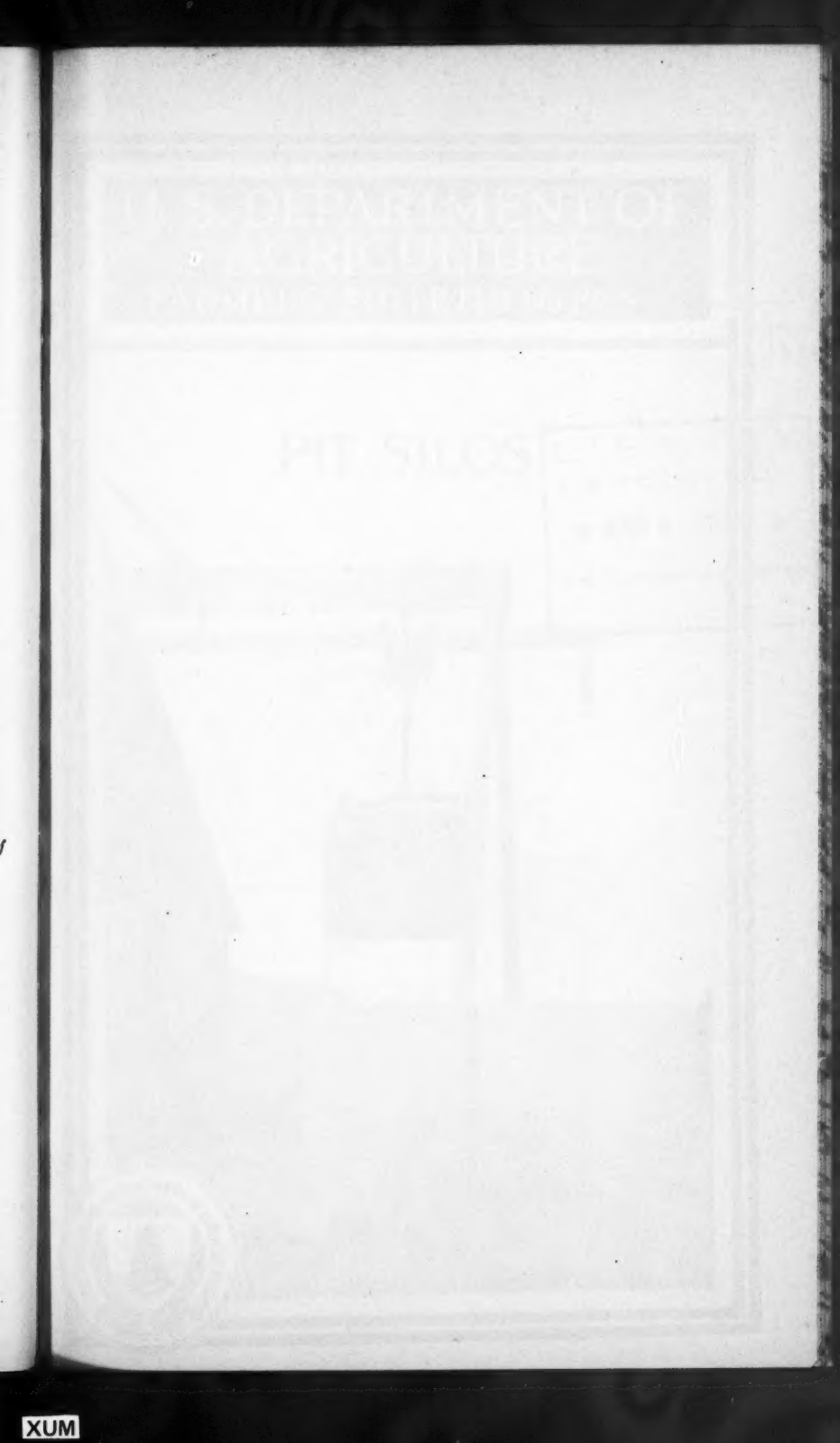

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FARMERS' BULLETIN No. 825

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PIT SILOS

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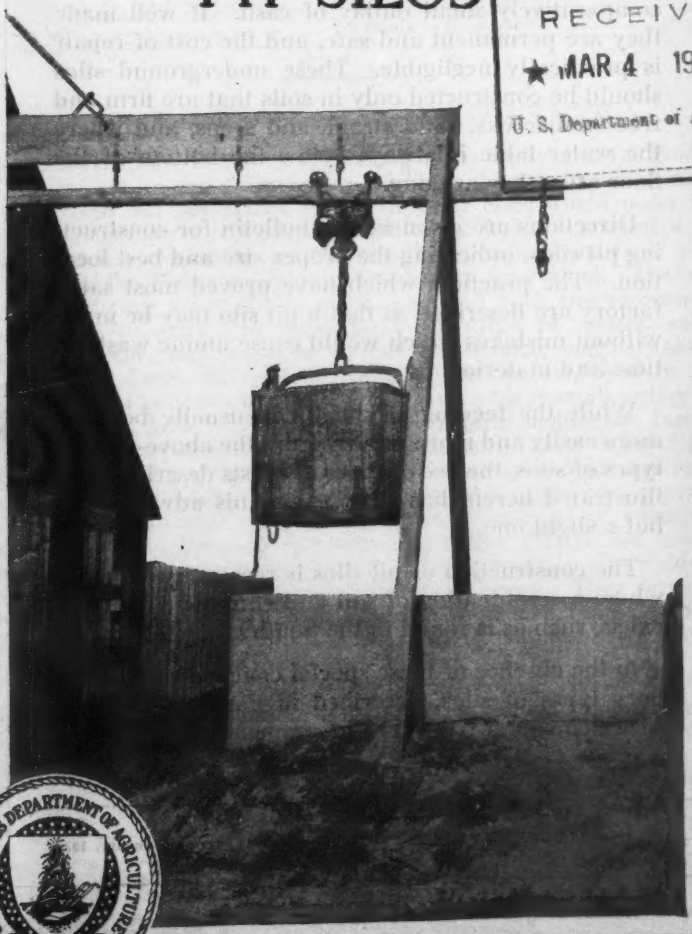

XUM

PIT SILOS have been constructed in considerable numbers in the Southwest during the last few years. Their growing use has resulted from the unsatisfactory service given by silos of wood under the prevailing climatic conditions, together with the scarcity of materials necessary for constructing masonry silos and the high cost involved in getting these materials on the ground.

Pit silos can be constructed by farm labor at a comparatively small outlay of cash. If well made they are permanent and safe, and the cost of repair is practically negligible. These underground silos should be constructed only in soils that are firm and free from rocks, sand strata, and seeps, and where the water table is always below the bottom of the floor after they are dug.

Directions are given in this bulletin for constructing pit silos, indicating the proper size and best location. The practices which have proved most satisfactory are described so that a pit silo may be made without mistakes which would cause undue waste of time and material.

While the feeding of silage can usually be done more easily and more rapidly from the above-ground types of silos, the use of types of hoists described and illustrated herein has shown that this advantage is but a slight one.

The construction of pit silos is recommended only where a combination of soil and climatic conditions exists, such as is found in the Southwest.

In the absence of these special conditions the ordinary types of silos, described in Farmers' Bulletin 855, Homemade Silos, are recommended.

Washington, D. C. Issued June, 1917; revised January, 1930

PIT SILOS

By T. PRYSE METCALFE and GEORGE A. SCOTT,[1] *Animal Husbandry Division, Bureau of Animal Industry*

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ADAPTATIONS AND ADVANTAGES OF PIT SILOS

PIT SILOS are becoming common in many sections of the Southwest. Their popularity is due chiefly to the remoteness of many farms from railroad points, which in many cases would make the cost of a masonry silo prohibitive, and to the fact that silos of wood often weaken rapidly under the peculiar climatic conditions prevailing in the Plains region and are destroyed by wind. The cost of constructing a pit silo is small compared with the expense of building a masonry silo, when large quantities of cement, sand, gravel, or tile, etc., must be bought and hauled long distances. In addition, some skilled labor usually must be employed in the building of a concrete or tile silo, whereas with a small outlay of cash, his own labor and that of ordinary farm hands, the farmer can construct a pit silo that will be a substantial asset to his farm.

Simply digging a "hole in the ground" does not provide a durable or satisfactory pit silo. A little extra care and expense put into the construction will well repay the owner in greater safety, efficiency, and durability. Properly constructed pit silos should last indefinitely, and the upkeep is very small. They can not be blown down, and there is nothing about the silo itself to decay. They preserve silage fully as well as or better than above-ground types; a more uniform temperature throughout the year is maintained in them; and the silage is never frozen.

Another distinct advantage of pit silos over other silos lies in the ease and low cost of filling them. Only power to cut the material is required, while with above-ground silos practically twice as much power must be used to cut the silage and elevate it to the top of the silo. Consequently, farmers having pit silos can more often afford to own their cutting outfits, and can fill their silos at the proper time without waiting to hire expensive outfits and extra men. The

[1] Revised by W. H. Black, senior animal husbandman, Animal Husbandry Division. Mr. Metcalfe resigned Dec. 4, 1919, and Mr. Scott resigned Jan. 31, 1915.

NOTE.—This bulletin is intended for distribution in sections where building materials are scarce and high priced, especially applying to the Southwest.

labor required to hoist out the silage is distributed throughout the feeding season, which comes during a period when other farm work is not pressing.

LOCATION—CHARACTER OF SOIL REQUIRED

Inasmuch as it is impracticable and even dangerous to dig a pit silo in a great many soils, the farmer should know the character of his soil before attempting to construct a silo of this type. The soil must be well drained, so that water will not stand in the bottom of the silo, and must be of such a nature that it will not readily cave in. Soils which contain bowlders or rocks are hardly satisfactory for pit silos, as the walls of the silo can hardly escape being materially defaced and weakened when the rocks are removed. Any firm, well-drained, and comparatively dry soil, free from seeps, rocks, and sand strata should be satisfactory. Where pit silos have not been tried, the farmer should study the soil and the depth of the water table by observing any near-by well. If this is not possible, it would be advisable to bore a 2-inch hole as deep as the silo is to be, and in this way to learn the character of the soil. The maximum height of any ground water which may appear at any time in this test well will indicate the lowest point to which a pit silo should be dug in that place.

If possible the silo should be near the feed lot, to reduce the cost of feeding. If the feeding is to be done in a barn, a distance of 6 feet at least should be left between the edge of the pit and the barn.

SIZE OF SILO

The diameter of the silo will be determined by the amount of silage to be fed daily, while the depth will depend chiefly on the length of the feeding season. Hence the farmer should know approximately (1) the number of stock he intends to feed, (2) the approximate amount of silage to be fed daily, and (3) the number of days silage is to be fed. With this information before him, the proper diameter and depth, respectively, can be decided on by consulting Table 1.

TABLE 1.—*Capacity of round silos*[1]

Inside diameter	Height	Capacity	Amount that should be fed daily	Inside diameter	Height	Capacity	Amount that should be fed daily
Feet	*Feet*	*Tons*	*Pounds*	*Feet*	*Feet*	*Tons*	*Pounds*
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12	45	104	755	18	30	132	1,700
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14	30	80	1,030	18	40	198	1,700
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The diameter of the silo should be such that after the silage feeding has begun, at least 2 inches should be removed from the surface daily. If less than 2 inches of silage is removed daily, the exposed silage will probably spoil, especially during warm weather. Make an allowance of from 4 to 6 feet for settling of the silage, but figure in the wall above ground in the total depth of the silo. A general rule which is followed in silo construction is that the depth of the silo should not be less than twice nor more than three times the diameter. However, pit silos are seldom deeper than 36 feet.

METHOD OF CONSTRUCTION

THE CURB

When the location and size of the silo have been decided on, mark off the trench for the curb with some such device as is shown in Figure 1, keeping the arm of the marker level.

Within these two outlined circles dig a trench about 2 feet deep and from 6 to 8 inches across the top. The inside wall should be kept perpendicular and smooth, and the bottom must be level. The concrete put into the trench forms the curbing at the top of the silo,

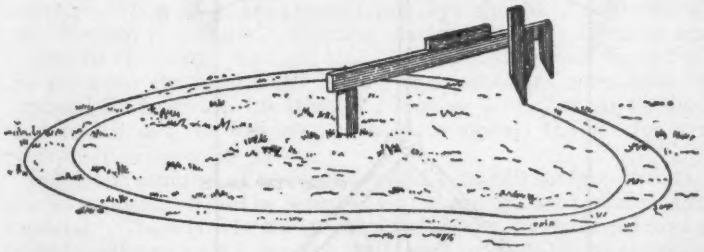

FIGURE 1.—Marking off the trench for the curb. Where the ground on which the silo is to be located is not level, the markers can be lengthened by holding a longer board against either marker, as indicated in the figure, moving it up or down to keep it touching the ground, but the scantling must be held level

and the curb of concrete will serve as a foundation on which a light wall and a cover may be built.

When the trench is dug, fill it with water to wet the ground thoroughly, and let it soak into the soil. Then put in the concrete, which is made of 1 part cement, 2 parts sand, 4 parts gravel or crushed rock, and the proper amount of water. To insure strength and durability the concrete must be reinforced. An ideal construction results from embedding in the concrete three or four ¼-inch or ⅜-inch steel rods connected so as to form hoops, one of which should be near the bottom and the other placed approximately at equal distances apart as the concrete is put into the trench. Strong wire mesh securely connected at the ends may be used instead of steel rods.

If a concrete wall is not to be constructed upon the curb, the latter should be extended about 2 feet above the ground, so that the soil can be banked up around it. Forms must be used for building the curb, or a wall, above ground. Farmers' Bulletins 1480, Small Concrete Construction on the Farm, and 855, Homemade Silos, give

valuable information and detailed instructions concerning the mixing and handling of concrete, reinforcing concrete, the construction of forms for walls, etc. They may be obtained free from the United States Department of Agriculture, Washington, D. C., and should be consulted in connection with the concrete work involved in building a pit silo, especially by those who are not thoroughly familiar with making and handling concrete.

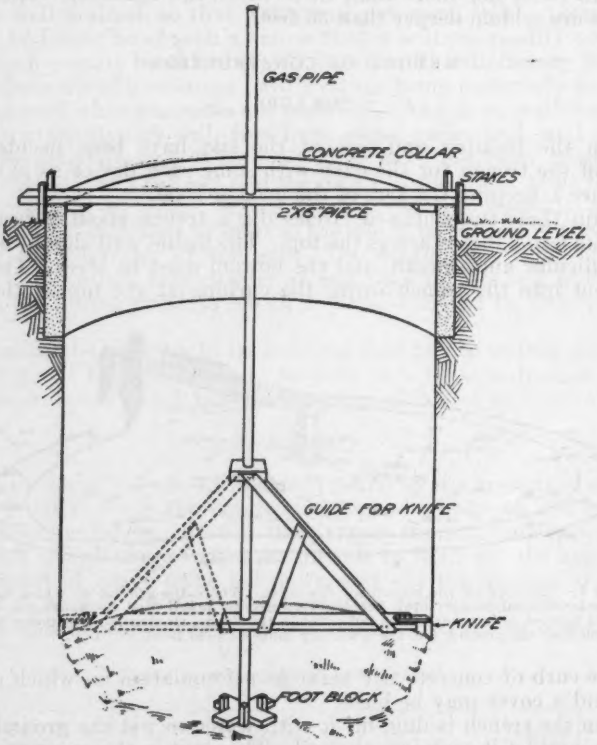

FIGURE 2.—Vertical section of a partially constructed pit silo, showing a device for making the wall perpendicular and smooth. (Adapted from Circular No. 6 of the Extension Service of the University of Arizona College of Agriculture)

EXCAVATING THE SOIL

After the concrete composing the curb has set well—or in about three days—the digging of the pit may be begun. Remove the soil, digging straight down from the inside of the curb. Be sure to keep the wall perpendicular and smooth. If the wall slopes outward, the silage will settle away, leaving an air space, and some silage will be spoiled. Should the wall slope inward, it will prevent proper settling of the silage.

Several devices have been used in helping to keep the wall straight and smooth. A simple plumb line is most often used, and a straightedge made from a 1 by 4 inch piece, used in connection with an ordinary carpenter's level, assists in keeping the wall both plumb and smooth. Figure 2 illustrates a device which has been used in the Southwest.

The stakes next to the curb and the blocks nailed on the lower surface of the 2 by 6 inch piece are put in place before the digging of the pit is started. The hole in the 2 by 6 inch piece through which the pipe passes is bored directly over the center of the silo. After each section of the pit is dug, the 2 by 6 inch piece is put in place, and a plumb line is dropped through the hole to locate the exact center in the bottom. Then the foot block is staked in place and the pipe lowered through the 2 by 6 piece, the guide, and into the hole in the foot block. The guide is then revolved, and the knife shaves the wall smooth, or indicates irregularities in the wall. When the wall has been smoothed to the approximate level of the foot block, the apparatus is removed, this section of the wall plastered, and digging is then begun for the next section. This is repeated for each section of 5 or 6 feet excavated.

In soils which are not too sticky when wet, digging will be made easier if water enough is run in at night to soak up the ground in the bottom. When rocks are encountered they should be removed without blasting, if possible. Careless blasting is likely to cause undue injury to the wall. In case blasting is done, no one should enter the pit after the blast until the air and poisonous gases have been replaced by fresh air. A limb of a tree, or a blanket, or the bucket used to lift out the soil may be used to agitate the air for a few minutes to remove the gases.

When the removal of rocks destroys the smooth surface of the wall, the defacements should be repaired by the use of metal lath or similar material. The metal lath or mesh should cover the damaged area and extend well out over the solid wall, and be fastened very securely with long, iron pins, so that it is flush with the surrounding wall. Large holes in the wall may be partly filled with concrete before being covered with the lath. Adobe mud, where available, is often used for this purpose.

If a carrier and track is to convey the silage away from the silo, it should be erected before the pit is dug, so that it can be used to remove and carry the soil away when digging the pit. The hoisting apparatus can be set up and used to lift out the soil while the pit is being dug, but it will pay to use a horse or team to lift it. The soil may be utilized in filling in around the silo to make an elevated and well-drained feed yard, and it is important that a foot or so of dirt be banked up against the curbing to prevent water from draining into the silo.

LINING THE PIT

When 5 or 6 feet have been excavated, the wall should be plastered about 1 inch thick with a mortar made of 1 part cement and 2 or 2½ parts of clean, sharp sand. Two coats will be required to do this, and at least two hours should elapse between the application of the first and second coats, but the second coat should be applied

before the first has become completely dry. A lining 1 inch thick is usually sufficient, but in soils which are not firm a 1½-inch wall would be safer.

Before applying the lining the wall should be dampened, in order to prevent the dry soil from absorbing the moisture too rapidly from the mortar. Before the plaster is set, apply one or two coats of a wash of pure cement and water, mixed to a creamy consistency. This may be done with a whitewash brush. The application of this last coat assists in making the wall stronger, smoother, air-tight, and almost waterproof. Keep the plastered wall damp for several days, as this will help the plaster to harden properly and make the wall stronger.

It will be found desirable to leave bare an inch or so of the earth wall immediately below the curb until the silo is completely dug. This will allow the curb to settle without "buckling" or cracking the lining below.

After the first section of 5 or 6 feet has been lined with the mortar and cement wash, digging may be resumed, and the work carried on in this way until the desired depth is reached. By completing the silo by sections in this manner the danger of caving in and the necessity of building scaffolding for the application of the lining are eliminated. Do not put mortar over the bottom, which should be left bare.

COMPLETING THE SILO

A wall about 4 feet high is now built on the concrete curb. This may be of concrete, lumber, concrete blocks, hollow-tile blocks, or brick. Woven-wire fencing has been used for this purpose; it is much better than nothing at all, as it will prevent persons or livestock from falling in, and when the silo is filled this wire wall can be filled also, so that when the silage settles, the pit will be nearly full.

Forms are necessary for building a concrete wall, which should be about 4 inches thick and reinforced with heavy woven-wire fencing. It will be necessary to erect scaffolding across the top of the pit from which the inner forms can be suspended in place. Consult Farmers' Bulletin 855 for directions for building forms and making concrete walls. A wall approximately 4 feet high is desirable, as it adds that much depth to the silo and affords protection against anything falling in.

An inexpensive covering of some sort should be placed over the silo. A simple board roof is sufficient. It is best to leave a space of about 2 feet or more at the top of the wall to allow a free circulation of air around the top of the silo, which makes less probable the accumulation of poisonous gases.

Where a man furnishes all his own labor, obtains sand and gravel at a small cost, and installs a homemade hoisting apparatus, a silo of considerable capacity may be constructed for a comparatively small cash outlay, as the cement is the chief item of cash expenditure.

HOISTING DEVICES AND FEEDING EQUIPMENT

The problem of hoisting and feeding silage from pit silos is not so formidable as it appears to many on first thought. This is evident to one observing the ease and rapidity with which feeding is done by

farmers who have pit silos. Practically all the devices now in use are homemade affairs, which are inexpensive. One of the most successful and simple types in use is illustrated in Figure 3 and briefly described herewith. The device consists of a swinging crane, pulleys, rope, and a box of some sort for the silage. A 4 by 6 inch piece may be used for the upright or mast, 2 by 6 or 2 by 8 inch pieces for the arm, and a 4 by 4 inch piece for the boom. Only sound timbers should be used. The upright should be braced from the top with heavy guy wires securely anchored. A horse is used to lift the silage. The silage box after being filled and hoisted can be swung over a wagon or attached to a trolley on an overhead track, or placed upon a truck, as is shown in Figure 4. Such a hoisting device may be placed so that it can be used to empty two or even three silos. Whatever kind of carrier for the silage is built

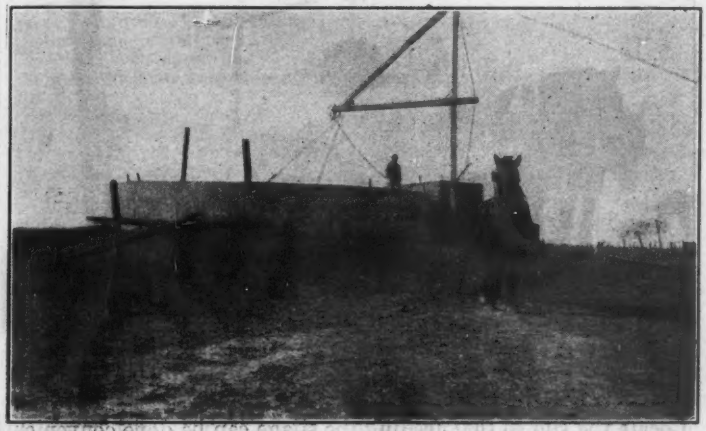

FIGURE 3.—The silage can be removed quickly and easily by the use of a horse

or purchased, it should have a trip bottom, end, or side, so that it may be unloaded easily.

The illustration on the title page of this bulletin shows one way in which a regular hay carrier and outfit is used to lift and feed silage from a pit silo. The track extends into the barn above or in front of the feed troughs. With the equipment shown here a horse is used to hoist the silage. However, it is possible to install a windlass for the purpose, and to use with this a simple trolley to which the silage carrier can be transferred after being filled and raised.

The kind of hoist and feeding equipment to be installed in connection with a pit silo should be determined largely by the amount of silage to be fed and the conditions which affect feeding. A farmer should install a hoist and equipment that conform to his particular needs and plans, keeping in mind the desirability of convenience, durability, and safety.

POISONOUS GASES IN PIT SILOS

Occasionally poisonous gases are formed in pit silos, and because the only means of ventilation is at the top, they may accumulate to

such an extent that it is dangerous to enter. This formation and accumulation of dangerous gases practically always takes place only when the silo is partially filled with fresh silage; consequently, particular care should be taken before entering a silo under those conditions. If a lighted lantern is lowered into the silo and continues to burn, it is safe to enter. When danger is suspected, thoroughly agitate the air, as mentioned in connection with blasting. While very little trouble has been experienced from this source, it is well always to be certain that poisonous gases are not present before entering the silo.

FIGURE 4.—The crane can be swung over the wagon by means of a small rope

POINTS TO BE EMPHASIZED

Locate the silo so that feeding the silage can be done conveniently.

The silo must be in firm, well-drained soil, which should be free from sand strata and rocks.

Make the pit the proper size and depth, according to the amount of silage to be fed.

Make the bottom of the trench for the curbing or collar level, keep the inside of the trench smooth, and put in a substantial collar.

Keep the wall of the pit smooth and plumb.

Make the mortar for the lining in the proportions indicated, first mixing well the sand and cement dry. Plaster this on to the dampened wall, as directed, and do not attempt to economize by making it less than 1 inch thick. Then keep the wall damp for several days.

Leave the bottom of the pit bare.

Remember that an efficient hoist greatly reduces the time and labor required to remove the silage.

Do not fail to inclose the pit with a wall of some sort, so that there will be no danger of anything falling into the silo.

Pit silos are usually constructed with the idea of permanency, so that it is in the interest of economy and safety to construct them well.

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